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Cancer Incidence Among Massachusetts Firefighters 1982 - 1986

Bureau of Health Statistics, Research and Evaluation
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CANCER INCIDENCE AMONG MASSACHUSETTS FIREFIGHTERS, 1982-1986

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EXECUTIVE SUMMARY

Firefighting is a strenuous and often dangerous occupation. In addition to the obvious safety hazards, firefighters are exposed to a wide variety of toxic substances, some of which are known or suspected cancer-causing agents. There is some evidence from previous epidemiologic studies that firefighters may be at increased risk of developing certain cancers.

The present study was undertaken in response to the Pension Reform Act (Chapter 697, Section 126 of the Acts of 1987) which directs the Department of Public Health to study cancer in firefighters. Researchers used data collected by the Massachusetts Cancer Registry during 1982-1986 to identify possible associations between firefighting and cancer in Massachusetts. The investigation focused on nine types of cancer shown in previous epidemiologic studies to be elevated among firefighters.

Information about "usual occupation" reported to the Registry was used to identify firefighters with cancer. For each of the nine cancer types, the observed number of white male firefighters with cancer was compared to the number expected based on cancer reports in two other groups of white males: 1) police - a group with socioeconomic and ethnic characteristics similar to those of firefighters, and 2) all other occupations (called the statewide reference group). Major findings are summarized below.

Melanoma

Firefighters had a statistically significant three-fold risk of melanoma of the skin compared to the statewide reference group (18 observed cases, 6 expected). When compared to police, this elevation was reduced but the risk remained significantly elevated for those aged 55-74 years (11 observed, 2 expected).

The melanoma excess may be partly explained by certain characteristics which are similar among firefighters and police, such as fair complexion which is known to increase

risk. Occupational exposures may also have contributed to the excess, especially among the cases aged 55-74 years. The finding of increased risk of melanoma among firefighters is consistent with several other studies. Because melanoma is easy to detect and has a very high survival rate when detected early, melanoma screening for firefighters should be considered.

Bladder Cancer

Firefighters had a statistically significant excess of bladder cancer compared to both police and the statewide reference group. There were 26 cases of bladder cancer among firefighters. This was about twice the number of cases expected based on the cancer experience of police (12 expected), and one-and-a-half times the number of cases expected based on the cancer experience of the statewide reference group (16 expected).

Excess bladder cancer has been observed previously among firefighters and several other groups of workers exposed to combustion products. Exposure to polycyclic aromatic hydrocarbons produced by the burning of organic material has been suggested as a possible cause of bladder cancer. Cigarette smoking is also known to cause bladder cancer. Firefighters in the current study did not appear to smoke more often than the reference groups. Therefore, it is unlikely that the bladder cancer excess was completely due to smoking.

Lymphoma

Firefighters had a statistically significant three-fold risk of non-Hodgkin's lymphoma compared to police (14 observed, 4 expected). There is some previous evidence that lymphoma is associated with exposure to benzene, which is present at most fires, often in substantial concentrations.

Other Cancers

Firefighters had excess pancreatic cancer and leukemia compared to police but these findings were based on small numbers and were not statistically significant.

In interpreting these findings, it should be noted that although statistical significance means that an association is not likely due to chance, it does not necessarily imply a causal relationship. For example, the association between firefighting and bladder cancer could be due to other factors (e.g. socioeconomic, genetic or environmental) rather than to the job itself. Furthermore, this type of study does not determine whether individual firefighters with cancer were actually exposed to substances known to cause cancer. Other factors to consider in interpreting the study results are the magnitude of the cancer risk (e.g. a larger cancer excess is more suggestive of a causal association than a smaller excess) as well as the consistency with the findings of other studies.

The present study is based on limited data and does not provide definitive evidence of a causal relationship between firefighting and cancer. However, the findings are consistent with those of other studies, and thus add weight to the existing body of evidence that firefighters may be at increased risk of developing certain types of cancer.

INTRODUCTION

Firefighting is a strenuous and often dangerous occupation. In addition to the obvious safety hazards such as smoke inhalation, falls, and burns, firefighters are exposed to a variety of toxic substances. These include various carcinogens such as asbestos, benzene, and polycyclic aromatic hydrocarbons.[1,2] Whether firefighters are at excess risk of cancer due to these exposures has yet to be determined.

Previous investigations of cancer mortality of firefighters have yielded inconsistent results. Studies based on the occupational information reported on death certificates have demonstrated increases in several different types of cancer among firefighters: non-Hodgkin's lymphoma excluding lymphosarcoma,[3] brain and nervous system and bladder cancer,[4] lymphosarcoma and lung cancer,[5] digestive cancer,[6] colorectal cancer,[7] and pancreatic, brain and nervous system cancers, and leukemia.[8]

In several cohort mortality studies in which firefighter employment records were linked to death certificates, no excess cancer was found.[9-11] Others, however, have demonstrated increased mortality due to colon, bladder, and brain cancer,[12] leukemia and skin cancer,[13] and male breast cancer.[14]

In order to examine cancer patterns among firefighters in Massachusetts, the present surveillance study was undertaken using cancer incidence data collected by the Massachusetts Cancer Registry. Case-control analyses, using occupational information obtained by the Registry, were conducted to examine potential associations between firefighting and the occurrence of nine different cancers which have been shown to be elevated in previous studies. Whereas earlier investigations of firefighters have examined cancer mortality, this surveillance study is based on cancer incidence data.

METHODS

Data

Subjects were identified through the Massachusetts Cancer Registry (MCR) maintained by the Massachusetts Department of Public Health (MDPH). The MCR is a statewide, mandatory tumor reporting system which began collecting data from hospitals and licensed clinics in 1982. Reportable diagnoses include all malignant neoplasms (with the exception of in-situ tumors and basal and squamous cell carcinomas of the skin), benign tumors of the central nervous system, and neoplasms of uncertain behavior. Completeness of reporting has been estimated to be at least 95%, based on comparison with national cancer rates.[15]

For each newly diagnosed cancer case, hospitals are required to report name, date of birth, sex, smoking status, primary site, histology, and usual occupation and industry. Primary site and histology are coded at the hospitals according to the International Classification of Diseases for Oncology (ICD-O) system.[16] Smoking status information is limited to cigarettes only and cases are identified as current or former smokers or as having never smoked. Usual occupation and industry is defined as the longest job held and is reported as found in the medical record. Occupation and industry are coded at the MDPH according to the 1980 U.S. Bureau of the Census (BC) system.[17]

Analysis

The study period was defined as 1982-1986, the first five years for which complete MCR data were available. Male cancer cases with a reported usual occupation of firefighter (BC code= 417) or fire chief (BC code=413) were included in the exposed firefighter group. (There were no female cases reported as firefighters during the study period).

Two unexposed reference groups were identified from the male cases reported to the MCR during 1982-1986: 1) State- cases with any occupational information reported other

than firefighter or fire chief; and 2) Police- cases reported as policeman (BC code= 418), police chief (BC code=414), sheriff (BC code=423), or correctional officer (BC code=424). Police were selected as a reference group because of their probable similarity to firefighters with respect to sociodemographic factors. Study subjects were limited to those aged 18 years or more at the time of diagnosis.

About one-third of the firefighters (100 cases) were reported as "fireman", a job title which can refer to either a firefighter or a furnace operator. A review of secondary sources of information (hospital and union records, death certificates, and funeral directors) was conducted to determine which of these were firefighters. Six of the 82 cases for which further information was available were found to be furnace operators and were excluded from the exposed group. The 18 cases which could not be verified were assumed to be firefighters and were included in the exposed group.

Standardized morbidity odds ratios (SMORs) were computed to measure associations between firefighting and specific cancer types. The SMOR in this study is calculated as the ratio of the odds of having the cancer of interest among firefighters to the odds among the "unexposed" reference population. The SMOR can be interpreted as the number of firefighters with the cancer of interest to the number expected, based on the cancer odds of the reference group.[18]

Age-adjusted SMORs for each of nine cancer types were calculated comparing firefighters to both reference groups -- Police and the State -- using six age categories (18-44, 45-54, 55-64, 65-74, 75-84, and 85+ years). The selection of cancer types for examination was based on previous evidence of associations with firefighting and sufficient numbers of observed cases ($n \geq 5$). These included cancers of the colon; rectum; pancreas; lung, bronchus, and trachea; melanoma of the skin; bladder; brain and other nervous system; non-Hodgkin's lymphoma; and leukemia. "Control" cancers included all

other cancers, except those of the organ systems of concern: digestive, respiratory, and lymphatic/ hematopoietic, because of their potential association with firefighting.

Analyses were performed using the microcomputer program dEPID.[19] SMORs were calculated by standardizing to the age distribution of the exposed group (firefighters). Approximate 95% confidence intervals for the SMORs were calculated using a variance proposed by Rothman.[20]

RESULTS

There were 321 male cancer cases diagnosed in Massachusetts between 1982-1986 and reported to the MCR as firefighters. The distributions of firefighters, police, and statewide males, by age at diagnosis, race, and smoking status are presented in Table 1. Firefighters were similar to both reference groups with respect to age and smoking status. All firefighters with known race were White. All subsequent analyses were conducted limiting both the exposed and reference populations to Whites.

Table I. Distribution of Cancer Cases by Age, Race and Smoking Status, Male Firefighters, Police and State, Massachusetts 1982-1986

	Firefighters		Police		State[a]	
Characteristic	#	%	#	%	#	%
Total Cases	321	100.0	392	100.0	29,277	100.0
Age						
18-64 years	166	51.7	230	58.7	14,310	48.9
65+ years	155	48.3	162	41.3	14,967	51.1
Race[b]						
White	315	100.0	377	99.0	27,827	97.1
Non-White	0	0.0	4	1.0	835	2.9
Unknown	6		11		615	
Smoking status[c]						
Never	71	24.9	98	29.3	6,782	26.8
Former	82	28.8	102	30.5	7,990	31.6
Current	132	46.3	134	40.1	10,499	41.6
Unknown	36		58		4,006	

[a]Only cases with known occupation are included.
[b]Cases with unknown race are not included in percent distribution.
[c]Cases with unknown smoking status are not included in percent distribution.

SMORs for the nine cancer types examined among the 315 white male firefighters are presented in Table 2. Statistically significant elevations were observed, using the State reference group, for melanoma (SMOR=292; 95% C.I.=170-503) and bladder cancer (SMOR=159; 95% C.I.=102-250). When the Police were used as the reference group, the bladder cancer excess persisted (SMOR=211; 95% C.I.=107-414) and non-Hodgkin's lymphoma was also elevated (SMOR=327; 95% C.I.=119-898); however, the melanoma risk decreased (SMOR=138; 95% C.I.=60-319). SMORs greater than 200 were also seen for pancreatic cancer and leukemia, but these findings were based on small numbers and were not statistically significant.

Table II. Standardized Morbidity Odds Ratios (SMORs) for Nine Cancer Types, White Male Firefighters Age 18+, Massachusetts 1982-1986

Cancer Type [a] (ICD-O Code)	Observed Number	Reference Group: State SMOR	State 95% Confidence Interval	Police SMOR	Police 95% Confidence Interval
Colon (153)	33	120	80-182	104	59-182
Rectum (154)	22	135	84-219	97	50-188
Pancreas (157)	6	98	42-226	319	72-1415
Lung, bronchus, and trachea (162)	71	122	87-169	130	84-203
Melanoma of skin (173, H 872-879)	18	292	170-503	138	60-319
Bladder (188)	26	159	102-250	211	107-414
Brain and other nervous system (191-192)	5	86	34-215	152	39-592
Non-Hodgkin's lymphoma (H 959-964,967-970, 972, 975-976)	14	159	89-284	327	119-898
Leukemia (H 980-994, exc. 984)	6	112	48-259	267	62-1154

[a]Code refers to primary site, except when preceded by H for histology

Table 3 presents age-specific SMORs for melanoma, bladder cancer and lymphoma, computed using the police reference group. Although melanoma was only slightly elevated among all firefighters compared to police, there was a notable excess among those aged 55-74 years (SMOR=513; 95% C.I.=150-1750).

Table III. Age-Specific Standardized Morbidity Odds Ratios (SMORs) for Melanoma, Bladder Cancer, and Lymphoma, White Male Firefighters, Massachusetts 1982-1986, Using White Police as the Reference Group

Age Group	Melanoma			Bladder Cancer			Lymphoma		
	N	SMOR	95% Confidence Interval	N	SMOR	95% Confidence Interval	N	SMOR	95% Confidence Interval
18-54	5	55	16-196	4	125	26-588	2	132	16-1072
55-74	11	513	150-1750	18	219	99-484	10	538	150-1924
75+	2	110	13-934	4	440	42-4626	2	220	17-2814

DISCUSSION

In this study we used Massachusetts Cancer Registry data for 1982-1986 to examine cancer incidence in firefighters, compared to police and the state as a whole. This type of study is useful as a surveillance tool, in order to generate leads about potential associations which can be followed-up with more in-depth etiologic research. Surveillance findings which are consistent with those of other studies are most worthy of further investigation.

Incidence data have several advantages over mortality data for studying cancer. Cancer registry information provides better diagnostic information than death certificates. Over 96% of the MCR cases are pathologically confirmed. Incidence data are also more valuable for studying non-fatal cancers, such as bladder cancer, which are often not listed on death certificates of cases who die of other causes.

One disadvantage of this study is the under-reporting of occupational information to the MCR. Because occupation is only available for approximately 50% of all MCR cases, the actual number of cancer cases among firefighters may be up to twice as high as is reported here. The numerator-based analysis conducted in the present study could produce biased risk estimates if the reporting of firefighter varied by cancer site. It was not possible to evaluate reporting patterns without an additional source of information on the usual occupation of all cancer cases. However, there is little reason to suspect that reporting of firefighter would vary by cancer site.

A second limitation is that the MCR occupational information is obtained from medical records and some misclassification of usual occupation is likely. Risk estimates based on this information may be biased in either direction if there is systmatic misclassification by cancer site. However, a recent study of Missouri Cancer Registry data[21] found that reporting of usual occupation was fairly accurate (70%) and that misclassification was random, which would bias risk estimates towards the null.

Another limitation is that the MCR does not provide information about actual workplace exposures. Grouping all firefighters together, as in the current analysis, would tend to dilute the effects of exposure and bias risk estimates towards the null.

The present findings are consistent with previous reports of excess melanoma, bladder cancer and lymphoma among firefighters. Excess melanoma mortality has been observed among New Jersey[13] and Boston firefighters.*[14] As in our study, the excess among N.J. firefighters was not notably elevated when police were used as the reference population. Police have been found to have excess skin cancer in several investigations.[5,13] One possible explanation for these findings is that the firefighter and police populations have relatively similar ethnic compositions. Ethnicity, or more specifically skin color, is a well-known risk factor for melanoma; individuals with fair skin are at increased risk.[22]

It is important to note, however, that firefighters were found to have a slight excess of melanoma in both the N.J. study and ours, even when compared to police. In the present analysis, there was a marked excess in the 55-74 year old age group, where the observed incidence was five times greater than expected. This finding suggests that occupational exposures may contribute to melanoma incidence in firefighters. Carcinogens, including polycyclic aromatic hydrocarbons (PAHs) in soot, are potential causal agents. PAHs are produced from the combustion of organic materials[23] and, hence, are present at all fires. Firefighters often have dermal contact with soot which penetrates their clothing.

Whatever the contributing factors are, firefighters do appear to be at increased risk. Establishment of melanoma screening for firefighters seems advisable, especially since melanoma is easy to detect and has a very high survival rate when detected early.

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* None of the melanoma deaths in the Boston study overlapped with the melanoma cases in the present investigation.

Firefighter populations are readily identifiable and accessible, making them suitable for targeted screening.[24]

Bladder cancer mortality has been shown to be increased among firefighters in Buffalo and Washington State.[4,12] One potential cause is exposure to PAHs, which have been suggested as a possible cause of bladder cancer.[25] Excess bladder cancer has been observed previously among other workers exposed to combustion products, including chimney sweeps[26] and aluminum smelter workers.[27]

It is possible that the observed bladder cancer excess could be related to cigarette smoking, if firefighters smoked more than the police or state reference groups. Based on the limited smoking data available, the proportion of current and former smokers in the three groups differ only slightly (Table 1). Also, lung cancer, which is much more strongly correlated with smoking, is not notably elevated (SMOR=130; 95% C.I.=84-203) among firefighters compared to police who do have a slightly lower reported smoking prevalence. Calculation of smoking-adjusted SMORs,[28] using the MCR smoking information, reduced the observed risk estimates for bladder cancer by only a small amount. Although the smoking data may not be completely accurate, we would not expect misclassification to differ for firefighters, police, and other occupational groups. Hence, it is unlikely that the observed bladder cancer excess in firefighters is completely due to smoking.

Excess mortality from lymphoma has also been previously reported among firefighters.[3,5] There is mounting evidence that lymphoma, like leukemia, may be induced by exposure to benzene.[29] Firefighters may be exposed to appreciable concentrations of benzene, which is present at most fires.[2] Benzene is vaporized from products such as gasoline, solvents, degreasing agents, and paint strippers, and is a combustion product of polyvinyl chloride, polystyrene, and other plastics.[1] Excess leukemia mortality[8,13] and incidence[30] among firefighters have been observed previously; we found excess incidence

based on six cases (not significant). Further study examining the possible association between benzene exposure during fires and lymphoma and leukemia is necessary.

We did not observe excess brain, lung, colon, or rectal cancers as seen in some other studies. This may in part be explained by differences between incidence and mortality data, methodological differences between the various studies, low power to detect weak associations, or random occurrence. Our findings of associations between firefighting and melanoma, lymphoma, and bladder cancer support previous observations and warrant further investigation to determine the potential causes. Melanoma screening for firefighters should be considered. Its advisability does not rest on proof that the observed excess risk is occupational in origin.

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